



**UNIVERSITI PUTRA MALAYSIA**

**GENETIC STUDIES IN SOME OIL PALM  
BREEDING POPULATIONS IN MALAYSIA**

**EMMANUEL KWAKU SEKE AHIEKPOR**

**FP 1981 2**

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**by**


**Emmanuel Kwaku Seke Ahiekpor**

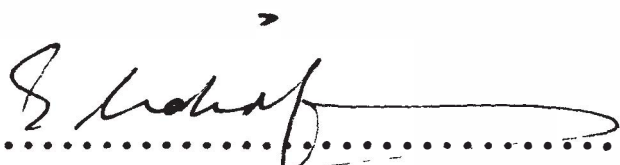
**A Thesis Submitted in Partial Fulfilment  
of the Requirement for the Degree of  
Master of Agricultural Science in the  
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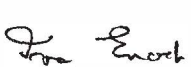
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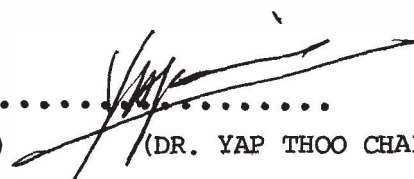


This thesis attached hereto, entitled "Genetic Studies in Some Oil Palm Breeding Populations in Malaysia" prepared and submitted By Emmanuel Kwaku Seke Ahiekpor in partial fulfilment of the requirements for the degree of Master of Agricultural Science, is hereby accepted.

  
..... (J.J. Haddon)

  
.....  
(DR. MOHD. KHALID MOHD. NOR)

  
.....  
(PROFESSOR I.C. ENOCH)

  
.....  
(DR. YAP THOO CHAI)

Date : 18 June, 1981  
.....

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## ABSTRACT

Five oil palm breeding populations were studied for heritability, phenotypic correlations, path coefficient analysis and yield performances involving oil yield, number of bunches, single bunch weight, percentage fruit-to-bunch, percentage mesocarp-to-fruit and percentage oil-to-wet mesocarp. The breeding populations consisted of different families of Deli Duras, Teneras and Pisiferas grown at Banting between 1968 and 1970.

Two methods, namely, parent offspring regression and combined (genotype x year) analyses were used to estimate heritabilities. Heritabilities using combined analysis were larger than those estimated using parent offspring regression. However, both methods showed that heritabilities for total bunch weight were lower than those of its component characters.

The correlation studies for oil yield and its components showed wide variation in association in both magnitude and direction. Nevertheless, number of bunches and single bunch weight negatively and significantly correlated in four of the five populations studied.

Re-examination of the correlation coefficients by path coefficient analyses indicated that number of bunches contributed significantly to oil yield in Population A. Single bunch weight and percentage fruit-to-bunch contributed significantly to oil yield in Population B. Contributions of the component characters to oil yield in Populations C, D and E were not significant.

The yield performance of the various progenies were generally good with high possibility of selecting promising genotypes from all the populations studied. The following promising Deli Duras were found in Populations A, C and E: UR 410/9, UR 427/28, UR 422/15, UR 444/10, BM 163/36, BM 1/42, BM 1/8, BM 1/175, BM 176/49 and BM 176/24. The promising Pisifera lines were BM 119/18, BM 119/16, BM 215/4, BM 390/10, BM 384/2 and BM 390/16. Nine promising Deli Dura progenies were identified in Population B and three Tenera progenies in Population D for selection and further testing.



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## CHAPTER I

### INTRODUCTION

Oil palm is an important source of vegetable oil, highly in demand for culinary and industrial purposes. The contribution of palm oil to the world's oils and fats output is increasing rapidly. In 1960, the world palm oil production was only 1.3 million metric tons making up 4.7 percent of the total production of the world's edible oils and fats, but in 1977, the world palm oil production increased to 3.6 million metric tons taking 6.7 percent of the total vegetable oil production (I.T.C. 1978).

The oil palm industry contributes significantly in various ways to the national economy and to the welfare of the people of the producing countries. Malaysia is currently the single largest world producer and exporter of palm oil; earning a substantial amount of hard currency needed to pay for essential imports. In 1971, Malaysia exported 0.5 million metric tons of palm oil valued at \$356.1 million. In 1977, the palm oil export increased to 1.5 million metric tons gaining \$1,651 million in foreign exchange (I.T.C. 1978). In the past few years, the oil palm plantations in



Malaysia have been expanding to meet the high palm oil demand (Tam, 1976). Hence, it is of utmost importance to step up systematic research into the breeding and other improvement aspects to sustain the industry.

In the past, the breeding materials in most palm oil producing countries were phenotypically selected within the available populations of narrow genetic base. Later, more comprehensive breeding programmes were initiated by the Institut National pour l'Etude Agronomique du Congo Belge (INEAC) in Zaire in 1950 (Hardon, 1976), by the Nigerian Institute For Oil Palm Research (NIFOR) in 1957 (Sparnaaij et al, 1963), by Institut de Recherches pour les Huiles et Oleagineux (IRHO) in Ivory Coast in 1957 and by the various oil palm research stations [such as Chemara Research Station (CRS) and Oil Palm Research Station (OPRS)] in Malaysia around 1950 (Hardon and Thomas, 1968).

Preliminary results of some of these programmes established the superiority of the Tenera hybrids from crosses between Dura (D) as female and Pisifera (P) as male, for commercial palm oil production. Due to some success in this approach, the objective of modern oil palm breeding has been to develop through breeding and selection improved Duras and Pisiferas



which are artificially pollinated to produce D x P (Tenera) planting materials with high oil production potential. Towards this end, and in order to increase the genetic variability of the breeding materials, oil palm breeders have introduced the necessary parent stocks of Dura, Tenera and Pisifera materials from oil palm breeding stations in Nigeria, Malaysia, Ivory Coast, Angola and Zaire. Selected palms from these stocks are crossed in various combinations to create Dura x Dura, Tenera x Tenera, Dura x Tenera and Dura x Pisifera progenies for evaluation and exploitation.

✕ Expected genetic progress and efficient selection, however, depend on the presence, magnitude and the identification of genetic variability in the important economic characters and the interrelationship of these characters. In addition, palm oil is made up of a number of measurable components, viz., number of bunches, single bunch weight, fruit-to-bunch ratio, mesocarp-to-fruit ratio and oil-to-wet mesocarp ratio. However, there are differences in the genetic variation of these component characters from population to population and various environments may cause differences in phenotypic variation in the components and the final yield. Consequently, it is desirable to evaluate the relative effects of these characters on the oil yield in the various populations under different environments in



order to estimate heritabilities of the characters.

The objectives of the present studies are, therefore, to examine the oil yield and its components of five oil palm breeding populations in Malaysia with respect to the progeny and population means, heritabilities and correlation coefficients. These genetic parameters are discussed in relation to the various yield characters of the parent breeding lines and their progenies in the light of selection for improved oil yield. It is hoped that the findings may be used to improve the breeding methods of oil palm.

## CHAPTER II

## LITERATURE REVIEW

2.1 Oil Palm Breeding Populations



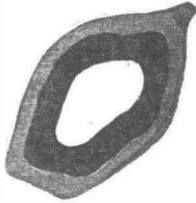
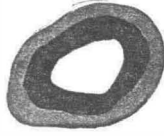






The oil palm (Elaeis guineensis Jacquin) is native to West and Central Africa from where introductions have been made to other parts of the tropics (Zeven, 1967). Oil palm was introduced to South East Asia, as four ornamental palms and planted in the Bogor Botanical Gardens (Indonesia) in 1848 (Jagoe, 1952). Hartley (1967) tracing the development of oil palm plantations in Africa and South East Asia noted that the first oil palm plantations were established in Sumatra in 1911 and in Zaire in 1920. Other countries like Malaysia, Nigeria, Ivory Coast, Republic of Benin, and Ghana followed later with plantations of various sizes.

In the past, unsystematic phenotypic mass selections were made from the natural palm groves in Africa and the ornamental avenue palms in South East Asia, to establish the early commercial plantations. However later, it was discovered that oil palm breeding populations were made of the three basic fruit forms, Dura, Tenera and Pisifera. These fruit forms are

distinguished by the variation in their shell thickness. The Dura fruit form has a thick shell; the Tenera has a thin shell with a characteristic fibre ring around the shell; and the Pisifera is shell-less.

The approach to oil palm breeding to establish the early plantations differed in Africa and South East Asia, because of the differences in the available basic breeding materials. In Zaire, the breeding objective of the Institut National pour l'Etude Agronomique du Congo Belge (INEAC) was to develop good Tenera fruit form palms only, since the Dura palms were found to be of poor quality (Van der Vossen, 1974). Some of the Teneras developed from these programmes have contributed substantially to the improvement of bunch and fruit component characters of the materials in the breeding programmes in Ivory Coast, Indonesia and Malaysia (Hardon et al, 1976). In Nigeria, the Dura and Tenera fruit forms were of comparable quality and the materials of the two forms were developed simultaneously by the Nigerian Institute For Oil Palm Research (NIFOR). Consequently, the Nigerian Dura palms and/or Deli Dura palms (Bogor origin) are utilised as Dura mother palms in the NIFOR and Ghana's Oil Palm Research Centre, for the Dura x Pisifera (Tenera) seed production programmes

## OIL PALM FRUIT FORMS

	LONGITUDINAL SECTION	TRANSVERSE SECTION
THICK SHELL ( <i>macrocarpa</i> )		
THICK SHELL ( <i>dura</i> )		
INTERMEDIATE (probably <i>tenera</i> )		
THIN SHELL ( <i>tenera</i> )		
NO SHELL ( <i>pisifera</i> )		

*The principal "forms" of oil palm fruit, distinguished by their internal appearance.*

(Sparnaaij et al, 1963; Van der Vossen, 1969; Hartley, 1977). In Malaysia, on the other hand, selections for the early plantations were limited to the Deli Dura populations of Bogor origin because they were the only available planting material at the time. Later, with the planting of Dura x Pisifera (Tenera) hybrids in the plantations, the Deli Dura palms remained the only source of Dura component of the hybrid in Malaysia and also in Ivory Coast seed production programmes (Hardon and Thomas, 1968; Hardon 1972). Teneras are preferred to Duras because they have relatively more oil bearing mesocarp tissues and therefore can produce more oil per bunch (Hardon, 1976). On the other hand, Pisiferas are not planted in commercial plantations because they are in most cases female sterile due to early abortion of the developing fruits.

Further prospections in the African oil palm groves and subsequent selections from the established plantations resulted in the development of a number of local breeding populations with characteristic features. But these populations have been conveniently grouped according to the thickness of the shell and the source of the material (Hardon and Thomas, 1968; Hartley, 1977). The Dura group is characterised by a small number of large bunches with thick shelled fruits. Those originating from the Bogor palms are known as Deli Duras and are identified

in the breeding populations as ex-Serdang, ex-SOCFIN or ex-Guthrie etc. The Deli Duras (ex-SOCFIN) were selected in the breeding programme of the Societe Financiere de Caoutchoucs (SOCFIN) with characteristics of high yields, low sex-ratio (ratio of female to total inflorescence) and heavy bunches. In a separate selection programme, Guthrie Ltd, also created a distinct Deli Dura population (ex-Guthrie) with high yields and high sex-ratio (Sparnaaij et al, 1963). Those Duras developed in the African breeding programmes are identified as Duras from the Cameroons, Angola, Dabou, or NIFOR (Aba, Calabar or Ufuma) Van der Vossen, 1978; Sparnaaij et al, 1963; Meunier and Gascon, 1972). The Tenera and Pisifera populations constitute the other group which is characterised by a large number of small bunches. Some of the breeding materials identified under this group are conveniently referred to as coming from the following sources: Yangambi, Sibiti, La Me, Pobe, Yocoboue, AVR0S, Angola and NIFOR. (Meunier and Gascon, 1972; Van der Vossen, 1974; Hardon et al, 1976; Hartley, 1977).

## 2.2 Exchange Programme

As breeding and selection in oil palm advanced, the need for international and national co-operative efforts became necessary. Thus, between 1945 and 1973, extensive Joint International Exchange Programmes and National Co-operative Breeding Schemes were organised

to exchange information and the various locally developed breeding materials. In 1946, on the initiative of the Institut de Recherches pour les Huiles at Oleagineux (IRHO), an international breeding project known as the "International Experiment" was inaugurated. Five oil palm breeding countries, namely, Zaire (INEAC), Malaysia (SOCFIN), Ivory Coast (IRHO), Republic of Benin (IRHO) and Congo (Brazzaville) participated in this international breeding project (Haddon and Tong, 1959).

Within Malaysia, the Ministry of Agriculture initiated a Co-operative Breeding Scheme in 1956 to avail itself of land from the participating estates to redistribute promising Deli Dura breeding materials. The participants were, Harrisons and Crosfield Sdn. Bhd., Kumpulan Guthrie Sdn. Bhd., SOCFIN and United Plantations Ltd. The scheme was extended to include comparative studies in the "Dumpy" and Tenera/Pisifera populations too (Haddon and Tong, 1959). Between 1963 and 1972, four private oil palm producing companies in Malaysia, namely, Dunlop Estate Bhd., Kumpulan Guthrie Sdn. Bhd., Harrisons and Crosfield Sdn. Bhd., and Unilever Ltd., contributed to organise an Oil Palm Genetic Laboratory (OPGL) to encourage "the development of a fundamental basis for oil palm research in South East Asia" (Corley et al, 1976).

In addition to the various multilateral exchange programmes, many oil palm breeding organisations have been involved in bilateral exchange programmes too. A special exchange programme started in 1970 between the Oil Palm Research Centre (OPRC) in Ghana and the Chemara Research Station in Malaysia. Some Tenera x Tenera seeds, Tenera pollen and Dura x Pisifera seeds were specially bred and exchanged with a quantity of Malaysian Deli Dura x Deli Dura seeds and pollen. (OPRC: Ghana Annual Report, 1970). In 1973, Nigerian Institute For Oil Palm Research (NIFOR) and Malaysian Agricultural Research and Development Institute (MARDI) organised a joint prospection to Eastern Nigeria oil palm groves to obtain new genetic materials and to conserve them for future breeding work. The genetic materials collected have been duplicated and grown in replicated trials and progeny blocks in Nigeria and Malaysia (Arasu and Rajanaidu, 1977). The objectives of the various inspections and subsequent exchange and crossing programmes have been to create genetic variation in the oil palm breeding populations for further improvement. Through active participation in the various exchange programmes, Kumpulan Guthrie Sdn. Bhd., and Harrisons and Crosfield Sdn. Bhd., have acquired and established a wide range



of variable oil palm genetic materials for evaluation and exploitation.

### 2.3 Variations In The Oil Yield And Its Components

Oil yield is a product of component characters, namely, number of bunches, single bunch weight, percentage fruit-to-bunch, percentage mesocarp-to-fruit and percentage oil-to-wet mesocarp. Studies have shown that wide variations exist for these characters with respect to the individual palms, progenies and fruit forms (Sparnaaij, 1969; Hartley, 1977). The observed variations are reported to be partly genetic and partly environmental (Blaak, 1965; Sparnaaij, 1969). Progress in improving these characters would be influenced by the relative magnitude of the genetic and non-genetic components of the total variation of each of the characters and their interrelationships.

Due to the large spacing requirement and the soil heterogeneity encountered in oil palm growing areas, the greater part of the variation in the bunch yield per palm is environmental (Sparnaaij, 1969). In view of this situation it has been recommended to use progeny data to study genetic variation in oil palm instead of individual palm data. A well-planted